AFTER-LUNCH PROGRAM AT JORNADA HEADQUARTERS

George Ellis, Presiding

Welcome -

Arthur Upson, Director Southwestern Forest and Range Experiment Station

H. M. Milton, President, New Mexico State College of Agriculure and Mechanic Arts

Remarks by representatives of participating and interested federal and state agencies:

Geo. Quesenberry, Director of New Mex. Agric. Ext. Serv.

C. U. Pickrell, Director of Arizona Agric. Ext. Serv.

Fabian Garcia, Director of New Mex. Agric. Expt. Sta.

Hugh Gardner, Dean of School of Agriculture

F. C. W. Pooler, Regional Forester, U. S. Forest Service

P. V. Woodhead, Asst. Regl. Forester, In Charge of Range Management, U. S. Forest Service

H. G. Calkins, Regional Conservator, Soil Conservation Service

C. F. Dierking, Regional Grazier, U. S. Grazing Service

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S. D. Aberle, General Superintendent, United Pueblos Agency, U. S. Indian Service

Ralph Will, Asst. Regional Director, Farm Credit Adm., Amarillo, Texas

Remarks by Stockmen -

Con Jackson, President, New Mex. Cattle Growers Assn.

Floyd Lee, President, New Mex. Wool Growers Assn.

A. D. Brownfield, Past President, New Mex. Cattle Growers Assn.

B. A. Christmas, Cooperating stockman and owner of livestock grazed on the Jornada Experimental Range

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SOME RESULTS OF RANGE RESEEDING TRIALS

By J. O. Bridges,
Ass't. Animal Husbandman, In Charge of Range Management,
New Mexico Agricultural Experiment Station.

This stop and the next one are being made in an endeavor to show you what the Experiment Station is doing along the line of range reseeding. This work was initiated on the College Ranch during the 1936 growing season by K. W. Parker. The plots at which we are now stopped are the 1939 plots or the fourth series tried. As you can see, the results are not astounding. Results in other years have been better and worse — in 1936 they were considerably better, in 1937 considerably worse, and in 1938 very much better. Our next stop will be at the 1938 plots.

As you can see, we have not discovered the way to make plants grow in this arid region. However, we have learned a few things about range reseeding that may be of value to others who wish to try it.

(1) Some sort of protection of seedlings from rodent grazing is necessary as well as from livestock grazing. (2) Proper species must be selected. (3) A straw mulch is a very decided aid to survival. (4) A prepared seedbed holds moisture better than an unprepared one. (5) Provision must be made for holding the moisture that falls on the area. (6) The seeds must be properly planted, not too deep and well firmed into the soil. (7) Rainfall must be average or above and properly spaced. We can do something about all of these suggestions except the last one — we can't make it rain. However, a study of rainfall records will indicate our chance for success in any given year.

This 10-acre area has been divided into 33 $\frac{1}{4}$-acre plots, with several 1/10-acre and 1/100-acre plots at the lower end. Ten of the $\frac{1}{4}$-acre plots were planted to plains bristle grass and 10 of them to

weeping lovegrass, an importation from Africa. The other 13 plots were seeded to different species that have been showing up rather well in past tests. One of these can be seen near the southeast corner; this is Rothrock grama, a native of Arizona. This grass has been doing very well each of the 4 years the tests have been carried on except the dry year of 1937. It is doing well even in unprotected plantings, along contours and brush fences, and even in an opening among the creosote brush without the aid of water conserving devices. A few plants have sprouted in nearly all the plots and two others have a fair stand — teff, an annual lovegrass from Africa, and tanglehead, one of our native southwestern grasses. The importance of selecting the proper species is indicated by the fact that among the many species seeded only a few are able to grow under these dry conditions.

We have tried several methods of seedbed preparation on this plot. The upper row of $\frac{1}{4}$-acre plots were contoured only. The next two were contoured and the natural vegetation undercut to kill it. The lower half of the area was chiseled to a depth of 1 foot at intervals of $5\frac{1}{2}$ feet of the vegetation undercut.

In 1938 we double disked the reseeding area, the results of which you will see at the next stop. In a year of poor growing weather the method of preparation seemed to have little effect on the growth of the plants. The moisture was better on the prepared area than on the unprepared but was not enough better to insure a stand. The area was under observation during one of the heaviest showers, and it held practically all the moisture that fell on it. This is very important in arid and semi-arid regions. We will now go to the next stop.

These plots were put out last year, which was a very favorable year for the establishment of seedlings — the rainfall for the four months of

June, July, August, and September being over 7½ inches. A study of the records for this region over the last 20 years shows that four such years occurred, and one of those really can't be counted as the big fall all came in one rain. Therefore, one can expect such a good year only once in every 7 years. However, the records also show one may expect about half of the years to be fairly good with some chance of success for the best species.

This west end of the area shows what can be expected if proper protection from rabbit damage is not given. The area outside the fence had as good a stand as this inside and did equally well through the growing season last year, but by April of this year all seedlings outside the fence were destroyed. The same thing may be expected where a reseeded area is grazed by cattle too soon after planting even though rodents are properly controlled by shooting or poisoning.

Of the 60 odd species of grasses planted on this area in 1/100-acre plots only about 10 of them can be considered to have any chance at all, and if one or two finally prove out, we will be very fortunate. Too much emphasis cannot be placed on selecting the proper species for one's locality. By the fence we have weeping lovegrass and Lehman lovegrass.

In this next plot is slender grama, a native of the Southwest but more abundant in Arizona than elsewhere. It has done very well here where it was mulched with straw. Last year the stand was excellent all over the plot but died out almost completely on the unmulched portion through the dry spring months. This same thing happened to nearly all of the other good species except tobosa grass and the deeper plantings of weeping lovegrass and the Australian panic grass. Disking of the area may have had something to do with this in that it left the soil loose and subject

to blowing where not protected by the mulch. It is well to keep this in mind in regard to seedbed preparation — don't leave the soil loose without some device for protecting it from blowing. In the eastern and northern parts of New Mexico a cheap and efficient straw mulch may be obtained by growing a crop of sudan grass the year previous to seeding the grass. The sudan grass is cut in an immature state to prevent seeding and at a height of about 1 foot so as to provide the straw for the mulch.

Indian rice grass is very slow getting started, but it appears that it is going to be able to establish itself on the mulched area.

We planted several species of dropseed in this row of plots. Two of these seem to be promising. Both are natives of this area and are prominent over the ranch as a whole. This first one is strict dropseed, and this one further back is mesa dropseed.

Tobosa grass seemed to do better without the aid of a mulch than any other species. It seems to be well on its way to establishing itself permanently here.

Proper depth of planting seems to be a rather hard question to settle. The seed of the lovegrasses by the west fence were covered very lightly; this gave the best stand and one that survived the winter well. The seeds in these strips were disked in to a depth of about $1\frac{1}{2}$ inches; this gave a poorer stand but one which stood the dry windy spring months better than the seeds that were covered about $\frac{1}{2}$ inch in the 1/100-acre plots. This is best illustrated by the Australian panic grass.

On this side of the area you can see the plots of plains bristle grass and Texas millet. Texas millet is an annual, native to the more moist parts of Texas. It produced a fine stand last year with sufficient seed to maintain itself over to this year and has again produced a good stand.

Plains bristle grass is a native of this region and is found in small amounts all over the Jornada plain. It is doing fine in this test plot and may prove to be a desirable species. It has an added advantage over most other grasses in that it is not as subject to rabbit damage as they are and may possibly be used without a fence.

PRODUCTION ON BLACK GRAMA RANGES

By J. H. Knox,
Head, Dept. of Animal Husbandry,
New Mexico Agricultural Experiment Station.

Perhaps no information is more important to the ranchman than the rate of stocking which will insure the greatest net return with sustained forage production and as stable an enterprise as the hazardous climatic conditions of this region permit. The data and discussion given here are not offered as a final answer to this problem, but rather as a contribution to its solution.

The pastures reported on are known as Nos. 1, 2, and 3, comprising an area of slightly over 11¼ sections. Prior to 1933 there was a good stand of black grama, with some dropseed. There were small areas of snakeweed and some mesquite. These pastures carried about 8 animal units per section through the following dry years without loss from starvation and with almost no supplemental feeding.

This report starts in the spring of 1936, when some estimated the kill of black grama to be as high as 90 percent. It might be said that this report covers a period of recovery from a severe drouth in which, as will be seen from the following table, the rainfall was below the 8½-inch average two years and above average one year.

Before studying the following table, it is important to understand what is meant by the term "proper use." This is the use which will provide maximum returns consistent with ample reserve for livestock and reproduction of the forage plants. In the case of black grama in this part of the State, we believe this to be such use as will leave 25 percent of the previous year's seedstalks on August 31. The selection of this date seems to be justified by rainfall records. In

four of the past five growing seasons the first good general rain which supported substantial grass growth over the entire ranch came after August 15; in two of these years it was after the first of September.

	Rain-fall	Animal units per section°	Beef per section	Beef per animal unit	Death loss	No. of average cows to produce same wt.	Percent of proper use	Est. carrying capacity	Est. production capacity
	In.		Lb.	Lb.					Lb.
1936-37	7.46	3.15	1631	518	1 cow	7.8	50	6.3	3262
1937-38	7.07	7.28	3848	529	1 cow	18.3	84	8.7	4581
1938-39	10.38	5.32	1832	344	1 calf	8.7	36	14.7	5089

° Animal units--1 cow equals 1; 1 two-year-old .8; and one yearling .65 units.

°° Average cows for this part of New Mexico produce about 60 percent calf crops and 350-pound calves

It will be noted that these pastures were used less than is considered "proper" during each of these years. In case of the first two years this was planned in order to allow the pastures to recover from the drouth. The low utilization in 1938-39 was because the Station did not have cattle enough to use all of the heavy growth due to favorable conditions in the growing season of 1938. The actual reduction in numbers this year was attributable to increased stocking of other parts of the ranch made possible by improvement due to light use in previous years. The high production the first two years was due to a weaning weight of over 450 pounds for calves and a substantial gain in weight of young cows. The much lower production the last year was because of a very dry spring in 1938, resulting in considerable loss of weight on the part of the cows and to a less extent to an average weight of about 420 pounds per calf on account of an earlier weaning date.

Surveys showing the amount of grass remaining August 31 have made it possible to estimate the carrying capacity and productive capacity of these pastures under conditions of proper use. The low carrying capacity the first year was due to the drouth years immediately preceding. The high capacity the last year was the result of much more than average rainfall in the growing season of 1938. That these figures are substantially correct is indicated by records from pasture 5--the one-section pasture in which this report is being made. This pasture lies adjacent to pastures 1, 2, and 3 and was probably superior to them, for it has no snakeweed or mesquite areas. The first two winters following the drouth it was stocked at a rate equal to 9.65 cows year long. As the result of this rate of stocking, the grama failed to improve as in the other pastures and the percentage of dropseed in the stand was greatly increased--a condition which has not been remedied entirely by subsequent stocking at the rate of $8\frac{1}{2}$ animal units. This may be easily seen from the point where the demonstration is held.

Doubtless this apparent injury would not have occurred after the pasture had completely recovered from drouth. However, it is well to remember that we are in a drouth or recovering from one a large part of the time.

Some additional information is given in the above table showing the results which may be expected from conservative stocking. It will be noted that death loss has been reduced to a minimum. The number of average cows required to produce the same amount of weight indicates that the production from even this low rate of stocking may compare favorably with average production. The most important point of all is not found in the table. This is that the range has improved from the condition where most of the black grama was dead in the spring of 1936 until it is now as good as before the drouth.

SUMMARY

Production varies greatly not only with the rainfall of the current but of immediately preceding years. It would seem unwise to base rate of stocking upon the better years.

Pastures stocked below the level of proper use recovered rapidly from the effects of a severe drouth. This was not so true of an adjacent pasture in which the rate of stocking was slightly above proper use for the first two years after the drouth.

These records, although not conclusive, indicate proper stocking for these pastures to be about nine or ten animal units per section.

The advantages of such conservative stocking may be enumerated as:

1. Increased production per cow due to number and weight of calves and weight of cows. (The calf crop in these pastures for the past three seasons has been 97 percent.)

2. Decreased investment in breeding stock because of smaller numbers.

3. Decreased amount of labor required to care for smaller number.

4. Reduced feed costs. Only 6450 pounds of cake were fed in these pastures during the three years reported.

5. Decreased death loss.

6. Increased sale value of cows due to greater weight and higher condition.

7. A more stable business because of reserve feed and maintained forage production.

THE ANIMAL HUSBANDRY RANCH OF THE NEW MEXICO STATE COLLEGE

The Animal Husbandry Ranch or State College Ranch was established in 1926-27 during the administration of H. L. Kent, President of the New Mexico State College, Fabian Garcia, Director of the Experiment Station and J. L. Lantow, Head of the Animal Husbandry Department. In 1926 the New Mexico State College purchased and leased from W. W. Turney the area known as the Summerford Ranch, which controlled the watering places within the adjacent Public Domain. However, in 1927, the area in Public Domain status was set aside by congressional act for the New Mexico State College, in order that this institution might carry on experimental work with range livestock. This latter acquisition of range land demarks the present boundaries of the ranch which consists of approximately 63,000 acres.

Largely unfenced and poorly watered at the time of establishment, development of the physical improvements has been somewhat restricted due to limited funds. Previous to acquirement by the college, the range lands had been too heavily grazed so that their condition was not favorable to efficient livestock production. However, since 1926, improvement in grazing conditions has been marked by a steadily improving plant cover, brought about by light stocking, control of the range through fencing, and proper range management. Some improvement was observed soon after establishment of the ranch, as noted in the New Mexico Experiment Station Annual Report for 1927-28, where it is reported that: "The range west of the Seldon Well is improving . . . due to protection from range horses. . . Many grasses are now becoming established even within a hundred yards of the Seldon Well, whereas formerly little grass was to be seen within one-half to a mile of it."

During the years 1935-36, a Division of Grazing CCC camp fenced the ranch boundaries, built necessary cross-fences and developed many needed watering places. This work was planned by P. E. Neale, K. W. Parker, and Lewis Carr. With the completion of these improvements and the construction of a scale house at Seldon Well and a laboratory and ranch building at Headquarters, the development work in fencing, water facilities, and equipment is about complete.

Since the establishment of the Animal Husbandry Ranch, experimental work has been done which has been of great benefit to the livestock industry of New Mexico. The early work consisted of studies in the supplemental feeding of range cattle under the direction of J. L. Lantow, who is now with the Soil Conservation Service, in charge of Range Management for the Southwestern Region. This early work led into studies of the effects of mineral deficiencies of forage. This work was done under the direction of J. L. Lantow and W. E. Watkins, Nutrition Chemist, assisting in the chemical phases of the work. Numerous publications on this phase of the work have been issued by the New Mexico Experiment Station from time to time; particularly noteworthy are:

Bull. No. 185. Supplemental Feeding of Range Cattle, by J. L. Lantow.

Bull. No. 214. The Assimilations of Calcium and Phosphorus from Different Mineral Compounds and Their Effect on Range Cattle, by J. L. Lantow.

Bull. No. 249. Mineral Supplements for Cattle on Phosphorus-Deficient Range, by J. H. Knox and P. E. Neale.

Tech. Bull. 246. The Calcium and Phosphorus Contents of Important New Mexico Range Forages, by W. E. Watkins.

The program of work of the Animal Husbandry Department has gradually broadened, in addition to animal nutrition studies, to include studies in:

1. Range management, concerned with maintenance and increase of grazing capacity.

2. Breeding range animals to increase their efficiency of production.

3. Range reseeding work.

4. Plant poisoning and animal diseases.

The work on the Animal Husbandry Ranch within recent years has been carried on under the leadership of J. H. Knox, who came to New Mexico State College in July 1935, as Head of the Department of Animal Husbandry. Prior to 1938 he was assisted in the Range Management phases of the work by K. W. Parker, who is now with the Range Research Division of the Forest Service. Since July 1937 J. O. Bridges has been carrying on the range management studies, giving special attention to range reseeding and effects of rodents. The tedious, practical phases of caring for the livestock and equipment are handled by Lewis Carr, Ranch foreman.

James W. Benner, Veterinarian in the Animal Husbandry Department is in charge of the work on poisonous plants and animal diseases.

Sheep breeding and management studies to increase wool and lamb production are under the supervision of P. E. Neale, Associate Animal Husbandman. This work is being done on the John U. Hinde Ranch near Wagon Mound, New Mexico.

W. E. Watkins has been carrying on a study of the chemical constituents of important New Mexico range forages and has also been assisting J. H. Knox in the blood-prosphorus study of range cattle.

D. A. Bell, a recent addition to the Animal Husbandry staff, will assume the work in genetics and animal breeding.

ORGANIZATION AND OBJECTIVES OF RANGE INVESTIGATIONS ON THE JORNADA EXPERIMENTAL RANGE

The Jornada Experimental Range which at the present time includes 193,394 acres was established by Executive Order in 1912 and since 1915 has been under the jurisdiction of the U. S. Forest Service. For nearly 25 years the area has been under experimental observation. During this period the livestock has been owned and managed by practical stockmen (W. W. Turney, W. H. Waggoner, Jerry Clayton, and B. A. Christmas) and the results of different systems and intensities of grazing have been observed by range specialists including James T. Jardine, now Director of Research for the Department of Agriculture; C. L. Forsling, now Assistant Chief in charge of Research for the Forest Service; W. R. Chapline, in charge of Range Research for the Forest Service; L. C. Hurtt, now in charge of Range Research at the Northern Rocky Mountain Experiment Station; Enoch Nelson, Professor of Range Ecology, Colorado State Agricultural College; J. D. Schoeller; and R. S. Campbell, who is now assistant to Mr. Chapline in the Washington Office of the Forest Service.

Under the present plan of organization of research in the Forest Service, the Jornada Experimental Range is operated as a branch station of the Southwestern Forest and Range Experiment Station, Arthur Upson, Director, and W. G. McGinnies, in charge of Range Research. The range studies on the Jornada Experimental Range are being conducted by Fred Ares, Superintendent, and K. A. Valentine, Junior Range Examiner. The shrub control experiments are being carried on by K. W. Parker, Associate Conservationist.

Stockman Cooperates to Secure Experimental Data

B. A. Christmas is the owner of the livestock run on the Experimental Range. He operates under a cooperative agreement with the Government based on the contribution of the land and technical services by the Forest Service and the livestock and practical livestock handling knowledge by the stockman. The objectives of the cooperative work are to determine and demonstrate improved methods of managing and utilizing range lands for livestock production and to obtain reliable data on related technical and practical phases of range management and utilization of value to public and private owners of range lands in southern New Mexico and adjacent states. The investigations and demonstrations include the following:

(A) A plan of range management which will minimize or eliminate the heavy loss of livestock due to periodic prolonged droughts.

(B) A system of utilization, consistent with (A) and based upon the growth requirements of the principal forage plants, which will maintain maximum range productivity and build up depleted range areas.

(C) The advantages of controlling both range and cattle under fence, in improving the general average grade of the cattle and increasing the percentage of calf crop.

(D) The grazing capacity of the native range lands when under control, and the comparative grazing capacity of similar adjacent lands under the open range system without control.

(E) The amount of salt necessary to satisfy the cattle at different seasons of the year and on different types of forage, and the number, character, and distribution of salting places to secure best use of the range.

(F) The loss of animals from all causes under controlled range conditions as compared with the loss on similar range not under control.

(G) The cost of handling cattle under fenced control over a period of years.

(H) The possibilities of range improvements by introduction of new plants, seeding, planting, conservation of runoff, etc.

(I) The number and distribution of livestock watering places necessary to secure proper use of range by cattle.

(J) The advisability of holding heifers which are to be used for breeding purposes away from bulls until the heifers are approximately two years old.

(K) The advantages of using supplemental feed to keep the cattle in good breeding condition and to prevent losses from starvation.

(L) Such other problems as may arise, which justify experimental study.

Representative Range Types Found on Jornada

There are four main types of range vegetation on the Jornada Experimental Range:

1. Black Grama Type - Most Valuable

The black grama ranges have the highest carrying capacity of any native range type at the lower elevations in southern New Mexico, and this species is one of the best forage plants in the entire Southwest. Under typical growing conditions it is the dominant grass and may occur in almost pure stands or with other species of grama and sand dropseed grasses associated with it. Black grama is nutritious and palatable throughout the year but will withstand grazing better if use is deferred until after the growing season.

The aim of management on the Jornada is to keep livestock off the black grama ranges as much as possible in summer by: (1) fencing, (2) herding, (3) closing waters, (4) removing salt and placing it within those types where livestock are to be grazed in summer.

The experimental results have shown that black grama ranges can be successfully and economically grazed and that they are good breeding ranges. The drought hazard is not excessive provided that the range is not consistently closely grazed. The fluctuations of volume and density between wet and drought years are considerable, but these can be overcome largely by conservative stocking.

2. Tobosa Grass Type - Good in Summer

The tobosa ranges usually occupy the more or less clayey bottoms subject to intermittent flooding. Tobosa grass often occurs in pure stands or may be found in intermingled patches with burrograss. Tobosa is nutritious during the growing season but becomes woody after maturity. The important management problem with the tobosa type is to secure economic utilization without overgrazing the adjacent range. This has been accomplished by: (1) controlling livestock by use of the electric fence and (2) cutting tobosa grass for hay. These two methods of use will be discussed more fully elsewhere.

3. Mesquite Sandhill Type - Too Prevalent.

Mesquite sandhills are very common throughout the Southwest. Probably there were large areas of mesquite sandhills before the white man came to this country, but there seems to be some evidence that it has spread in recent years. While the mesquite sandhills have a very low grazing capacity, they are considered by stockmen as good winter and spring ranges. Because of their low grazing capacity, however, they are

not considered as a desirable replacement for black grama ranges. The experimental work at the present time follows along two main lines: (1) how to prevent the spread of sandhills into good grassland; (2) how to restore sandhill areas which were formerly grassland.

4. Blackbrush-Creosotebush Type - Poor Range

Blackbrush and creosotebush form one of the poorest range types in the Southwest. The shrubby species furnish little or no forage, and perennial grass and weeds are usually scarce or absent. Probably little or no improvement can be expected where the type is well established, but where it has replaced a grass and weed cover, there is some chance for improvement. Our investigative work is aimed to develop methods of improvement by: (1) restricted grazing; (2) water retention and spreading; and (3) reseeding.

Present Management Program Result of Long Study

The present management plan for handling livestock is based on 25 years' study of livestock management and the reaction of the range vegetation to various intensities and seasons of use. For management purposes the range is divided on the basis of summer and winter use. The tobosa and blackbrush-creosotebush types are used in summer while the black grama and mesquite sandhills types are used in winter. The tobosa type is most advantageously used in summer while the mesquite sandhill type is most advantageously used in winter. The black grama type could be used at any time during the year, but experience has clearly demonstrated that best results are obtained when use on this type is deferred until winter.

Grazing Capacity Accurately Determined

The grazing capacity of the entire experimental range has been calculated to be 1,647 head year long. This figure is based on actual use during the past 25 years by livestock and by an annual inventory of forage resources. Quadrats and other check plots have been used to determine the reaction of the vegetation to this degree of stocking. These plots show that even though there are some fluctuations in the density and volume of forage produced from year to year, there has been no loss of density or volume over a 25-year period on this basis of stocking. In fact, this degree of use has allowed for restoration of range areas which were formerly depleted.

While the capacity of the range is calculated to be 1,647 head year long, the basic herd consisting of breeding cows, bulls, and replacement heifers is only a little more than half of this number. This allows provision for the raising of calves and steers, and the number of steers is regulated by the yearly fluctuations in f rage production. During years of abundant forage production additional steers may be brought in, or those produced on the range may be held over for a longer period. On the other hand if the fall forage inventory shows a short forage crop, the calves may be sold in the fall in order to insure adequate forage during the year for the breeding stock. Except under such drought conditions, calves are rarely sold in the fall but are usually sold as yearlings in the spring or following fall.

The system of conservative stocking has practically eliminated the need for supplemental feeding on the Jornada. Bulls are sometimes fed to condition them for better service. A few weak cows usually have to be fed each year regardless of the range conditions but there is

never occasion to feed the entire herd to save it from starvation. Calves and yearlings are sometimes fed through winter, not from necessity, but to obtain the added weight and increased profits from the spring sales.

In order that stockmen may give credence and accept the experimental work being done on the Jornada it is a matter of first importance that the venture be a proven financial success for the cooperating stockman. Otherwise the project would fall in the category of the surgeon's report posted a few decades ago which read, "The operation was a success but the patient died."

A study of production costs on the Jornada was undertaken to cover the 9-year period, 1928 to 1936 inclusive. This period represented average stocking and ranching conditions on the Jornada. The study showed that the gross receipts per cow averaged $22.93 per year and that for calves, $34.63. After applying the various items of running expense, indirect and interest charges listed below, it was found that the annual cost of maintaining a cow on the range was $17.65 while the annual calf cost was $26.64. The net proceeds per cow received during the period averaged $5.28 per year. The average net proceeds per calf during the period was $7.99 per year. These figures represent the profit yielded after deducting all cash expenditures for running costs, indirect charges, such as cow replacement losses and depreciation of improvements; and interest charges on operator's capital investment such as cattle, land and improvements.

If interest charges on fixed capital investment are not included in the cost as is usually the case, the net proceeds per cow are raised to $9.08 per year and for calves $13.72 per year. This represents a neat return on an investment such as the Jornada size of outfit.

CONTROL AND ERADICATION OF SNAKEWEED

By Kenneth W. Parker, Associate Conservationist,
Southwestern Forest and Range Experiment Station.

About 2 years ago the Southwestern Forest and Range Experiment Station undertook detailed studies of the control and eradication of various noxious range plants such as cacti, mesquite, burroweed, and snakeweed. The work on the Jornada Experimental Range is concerned chiefly with snakeweed together with preliminary studies of creosotebush and mesquite.

The area that we are now in is one of three similar areas devoted to this study. Snakeweed (Gutierrezia sarothrae), generally considered worthless as forage, has occupied extensive areas of range land in the Southwest, largely within the last 50 years. There is little doubt that snakeweed was present in the early days and probably in dense stands on immature or infertile or disturbed soils, much as it is today. The first settlers noticed that it was confined chiefly to rocky ridges and gravelly slopes. Then in a few years it began to become noticeable around water holes, along trails, and wherever there was a concentration of livestock. There is a good deal of evidence to indicate that snakeweed comes in following continued heavy grazing. Many stockmen agree with the viewpoint that snakeweed is an indicator of overgrazing. However, there are others who believe that snakeweed is sufficiently aggressive to invade and crowd out the native range grasses.

In addition to causing reduction in grazing capacity, we find that snakeweed has long been suspected as a poisonous plant. It is claimed by Arizona stockmen that sheep and horses are poisoned by snakeweed, which interferes with the normal functioning of the kidneys. Similar observations

have been made by New Mexico ranchers who also assert that grazing snakeweed in the spring causes abortion. There is some experimental work to substantiate these assertions.

Consequently, southwestern stockmen have been concerned with the spread of the plant and requested information as to the most practical methods of eliminating snakeweed from the range. The problem is largely one of control rather than complete eradication, since snakeweed frequently occupies a necessary and vital place in plant succession and provides ground cover which greatly retards accelerated erosion.

In studies of the eradication of snakeweed the work was divided into two sections. One section of the work is largely demonstrational. This phase will be discussed later. The other section of the work is concerned principally in finding an effective and practical method of killing snakeweed. Accordingly, 200 small test plots (1/50-acre each), located about 1 mile north of here, were subjected to 24 different treatments repeated at intervals of 3 months, starting in the latter part of April 1938. As regards the various mechanical and chemical methods used, we are prepared to report the following observations:

1. Grubbing was effective (90 percent kill or better) at all times of the year.

2. Mowing gave some promise and will be tested on more compact soil types.

3. Burning with a flame gun was effective except during the dormant period of winter.

4. Sulphuric acid sprays, varying in strength from 2.5 to 10.0 percent, were ineffective at all times of the year.

5. The chlorate sprays, both atlacide and sodium chlorate, in concentrations above 10 percent, were effective in killing snakeweed at all seasons, except during spring, the typically dry period of the year.

6. Mixtures of Colemanite or borate ore with sodium chlorate, although there is not the fire hazard involved as with

chlorate sprays, are less effective and more expensive.

7. Kerosene and diesel oil were ineffective at all times and their use is not recommended.

8. Diesel oil sprayed on snakeweed followed 10 days later by igniting the plants yielded erratic results, and since it is more expensive than burning with a flame gun, it is not recommended.

9. Due to the human error involved in application, all methods of eradication will have to be repeated at least once and preferably the year following application in order to clean up the remainder of the snakeweed stand.

The area that we are now in is one of three similar areas which form the demonstrational phase of the snakeweed study. The methods of eradication used were those which appeared most promising or at present are in use by stockmen and consisted of burning (with a flame gun, since there was not enough plant growth to broadcast burn), grubbing, and spraying with a 15-percent solution of sodium chlorate. Some of the plots were also reseeded to mesa dropseed grass.

In this area as well as the other study areas, 32 plots (.1 acre each) have been so arranged that the data can be analyzed statistically. The plots are arranged into four blocks with eight plots in each block. Thus by the use of fences each block of plots can be grazed as desired, and we are observing the effects of total protection (except rats and mice), protection from cattle year long, protection from cattle during the growing season, and year-long grazing. The experiment, which was started in the summer of 1938, has not run long enough to indicate what the effects of grazing or reseeding will be on the snakeweed stand. We can at this time, however, present some of the preliminary results of our eradication work. Before doing this I would like to point out that, in general, the value of range lands is so low that the expenditure of any great amount of money in eradication work is not warranted. More-

over, so little is known concerning the best and most effective method of snakeweed control that it seemed desirable to secure such information.

One of the most interesting things about this area is the natural reduction in snakeweed stand caused no doubt by an insect attack which took place following the start of the experiment. We are also studying the possibilities of insect control insofar as we are able to do so. In this area, approximately 60 percent of the plants have been killed by insects and most of the remainder seriously damaged. When these plots are averaged in with those of the other two areas, we find, however, only a natural decrease in snakeweed on the untreated plots of 13 percent as shown in the following table.

Comparison of treatments as to effectiveness and cost as applied to dense stands of snakeweed (3,000 to 5,000 plants per acre)

Treatment	Number of .1 acre plots on which data are based	Percent of plants killed	Man hours required per acre treated	Amount of chemical per acre	Total cost per acre*
None (check)	24	13	- -	- -	- -
Burning	24	85	9-3/4 hrs.	10.1 gal. Kerosene	3.94
15% Sodium chlorate	24	91	6¼ hrs.	59 lbs. of Sodium chlorate	7.46
Grubbing	24	87	6½ hrs.	None	1.63

*Labor plus chemical - Labor at 25¢ per hour, kerosene at 15¢ per gallon, sodium chlorate at 10¢ per pound.

On these large plots grubbing was found to be the cheapest and most practical. However, in other situations as on extremely rocky soils or in brushy areas burning or sodium chlorate sprays may be better adapted.

Burning with a flame gun or "pear burner" is a practical method of eradicating snakeweed from small spots but too costly for wide application. Broadcast burning would have been used if there had been

sufficient plant growth on the ground to carry a fire. At first glance broadcast burning seems to be one of the cheapest and most practical methods available, but when we analyze it more closely, we find that this is often not the case. A satisfactory combination of low moisture content and sufficient volume of inflammable material to carry a fire are seldom obtained, and when such conditions do occur, there is usually some other factor which either prohibits the use of fire or else makes its use unsatisfactory. Fire consumes 1 year's feed on the area burned and may destroy all the feed on a ranch unit if it gets out of control. Furthermore, little is known about the effect of fire on either the perennial forage grasses or on the soil. It is known that fire has resulted in accelerated erosion.

Sodium chlorate sprays cannot be recommended in general for application on snakeweed because of their cost and the hazard involved in their application. They are, however, very effective in killing snakeweed, if properly applied, and may be practical on small spots where grubbing and burning are inadvisable.

The question naturally arises: "Will eradication of snakeweed result in greater production of grass?" It is probably too soon to draw definite conclusions as to the effect on the grass of eliminating snakeweed competition. However, our data show that in the case of plots which were grubbed there was a 196 percent increase in grass above the natural increase on untreated plots. In the case of burning, the increase in grass was 54 percent and for plots treated with chlorate spray 14 percent for the first year.

THE USE OF ELECTRIC FENCE IN CONTROLLING LIVESTOCK ON THE RANGE

By Fred N. Ares, Superintendent,
Jornada Experimental Range.

Electric fences have shown considerable promise as a means of controlling the distribution of livestock on the range. Tests with electric fences on the Jornada Experimental Range have indicated that this type of fence can be very effectively used under certain range conditions but that some improvements will have to be made in the electrical equipment if it is to be universally successful under all conditions.

In August 1938, 3½ miles of one-wire fence was constructed around one of the large tobosa flats on the Jornada for the purpose of holding cattle on the tobosa summer feed and at the same time protecting the surrounding grama grass from heavy use during the growing season. Following the heavy rains in July, the tobosa grass was green and succulent, and when the fence was built, the soil was very damp. However, before the electrical unit ordered arrived, the soil had dried out thoroughly, and the first results on this dry soil were disappointing. About 140 yearling heifers were placed inside the enclosure, and at first they passed back and forth under the wire freely. After about 3 days a light shower fell wetting the ground to a depth of about one-half inch, and following this there was no more passing back and forth under or even approaching the charged wire. A trail in the moist sand inside showed that the animals never came closer than 4 feet of the wire, and salt placed near the line was approached with extreme caution and from one side only.

As a trial, the yearlings were kept in the enclosure about three weeks during which time none escaped. The wire was then taken down, and the yearlings had to be driven out of the enclosure. It is believed that none would have voluntarily passed between any of the standing posts even after the wire had been let down, at least not for some time afterwards.

During the 1939 season, rainfall was so deficient on the area fenced in 1938 that it was not possible to use it for further tests, but a smaller pasture was constructed where water and feed were available. It was stocked with a small herd of cattle and functioned very satisfactorily after the soil became moist.

A further test to determine the value of the electric fence in segregating poison plant areas was carried out this year. A heavy infestation of the poisonous drymaria was found near the south boundary, and being adjacent to the fence, it was possible to enclose a large area with only 3/4 mile of the fence. This proved to be very effective in keeping cattle away during the danger period.

The chief value of such an enclosure on ranges such as the Jornada seems to be that of holding cattle on summer feed especially where such feed areas are intermingled with and sometimes entirely surrounded by range supporting grama grass which must be reserved for winter use. For this purpose these one-wire fences can be constructed quickly and cheaply and can be easily removed when no longer needed. Other uses suggested by the ease of construction or moving these fences are: segregation of poison plant areas, holding non-breeding stock such as yearling heifers separate, and holding breeding cows and bulls together in an effort to increase the calf crop. The breeding period usually coincides with the

summer season when it is desired to confine cattle closely as possible on summer feed areas.

The cost of electric fences varies from $20 to $35 a mile, depending upon the length of fence built, type of post (metal or wooden), and type of electrical equipment used. The maintenance cost is very low. The electrical current may be supplied by an ordinary 6-volt auto storage battery which will run 4 or 5 months before it is necessary to recharge. The wire must be well insulated from contact with the ground and patrolled frequently, especially when first used, to repair any short circuits or ground. The better control units have a device by which grounds are indicated at the control box. Electric fences have been rather universally successful wherever soil moisture conditions are such as to insure a good electrical contact. They should work out successfully on Southwestern ranges if the difficulties of making satisfactory contacts on dry soils can be overcome. It is expected that some improvement can be made in the electrical equipment which will increase the effectiveness of the electric fence under dry soil conditions. Also it has been found that if the livestock become "educated" to the electric fence, they will respect it from then on. This educational training can be accomplished by holding livestock in small enclosures with an electric fence, or it may be accomplished by erecting the fence on the range when the soil is moist. This latter method is probably much more practical as far as range operations are concerned.

TOBOSA GRASS HAY

By Fred N. Ares, Superintendent,
Jornada Experimental Range.

Tobosa grass (Hilaria mutica) is one of the important southwestern range grasses found on the plains of West Texas, New Mexico, and Arizona. It comprises about one-third of the total feed resources on the Jornada Experimental Range. Because of its importance as a forage resource, it is necessary that the fullest possible use be made of it consistent with maintenance of the range.

Although tobosa makes some growth in winter and early spring, the greatest volume of feed is produced during and after the late summer rains. It then grows luxuriantly on the adobe clay soil of the low swales or slight depressions which receive excess flood water from adjacent higher ground. Under such moisture conditions, tobosa grass grows rapidly producing a large volume of summer feed and has a relatively high grazing capacity for a short period. Because tobosa grass is palatable only during the growing season and becomes wiry and relatively unpalatable during the fall, it is necessary that the grass either be grazed or harvested during the growing season if the fullest possible use of the range type is made. It is desirable that some of the growth be left to maintain the vigor of the plant for succeeding years, but any surplus over the physiological requirements of the plant should be harvested. If the entire vegetative production of tobosa is allowed to accumulate, the woody stems remaining in the grass tufts hamper use of the current year's forage.

The accumulation of undesirable woody vegetative material can be prevented in three ways: (1) concentration of grazing use during

the summer growing season; (2) mowing; and (3) burning. While burning will effectively remove the accumulated dead material, this practice is not recommended as it is dangerous, may be detrimental to the stand of grass, and burning does not provide for the economic use of the forage produced.

Since removal of the left-over growth by burning is often practiced in the tobosa range areas, several such tests were made on the Jornada on selected areas. These tests revealed that there is no doubt that fire is an effective and easy means of removing the old growth, but they also demonstrated that the heat generated in the process, especially when burning is done during a dry period, is likely to be injurious to the plant and, if continued year after year, may result in loss of density and volume of forage produced during subsequent years. A plot burned in 1936 showed a 6-percent loss in density in 1937, and in 1938 a further loss of 21 percent of the original 1936 plant density was recorded. This, translated in terms of volume of forage over a large area, means the loss of several tons of feed. Also, in addition to the possibility of permanent damage to the plant, there is always the risk of fire getting out of control and destroying a large amount of other forage.

Whenever it is not possible to obtain full use of this grass by grazing, it is thought that harvesting for hay is the next best solution to the problem. The cutting not only removes the objectionable surplus growth, but if done at the proper time of the year, will also provide a valuable supply of feed which can be used during later critical periods of feed shortage. A number of ranchers fortunate enough to have a quantity of this grass on their range provide themselves in this way with

cheap provender which can be used in supplemental feeding during drought periods and for the few weak cows found in the winter and spring on every ranch which require feeding regardless of range conditions.

The hay is cut by an ordinary mowing machine, stacked on the spot, or if hauled to a distant point, it is baled. Then in case of severe drought, which often strikes in the Southwest, the rancher is provided with a large amount of feed which is very satisfactory when fed as roughage along with oil cake or other concentrates and can be cut and put up in prairie stacks for less than $4.00 per ton by the average rancher. Considering that baled alfalfa hay from nearby irrigated farms will run as high as $25.00 a ton during drought times when the demand is great, this fact will challenge the attention of stockmen who are on the alert for ways and means of reducing their overhead.

During the past three years experiments have been conducted to determine the cost of putting up tobosa grass as hay and its value for winter feeding operations. In 1937 three small areas, aggregating about 8 acres in extent, were selected for cutting, and in August 1938 a total of 33 acres were cut. Both years an ordinary McCormick-Deering mowing machine and rake was used. Because no satisfactory teams were available, the motive power was furnished by a light truck which proved very satisfactory for the purpose due to better regulation of speed on the rough spots. The grass was cut and allowed to dry about 8 hours before raking and hauling.

The eight acres cut in 1937 yielded about 4 tons of hay, while the 33 acres cut in 1938 yielded 21 tons or about two-thirds of a ton per acre. Because the grass had not been cut or closely grazed previously there was some old growth collected along with the fresh current

growth. It was not in sufficient quantities to affect the use of the hay by livestock, and by confining cutting operations to the same areas year after year, this objectionable feature will be eliminated.

In 1937 the cost of the hay, including labor, supplies (gas and oil), and hauling the hay several miles to the stockyard was $5.42 per ton. Since $1.02 of this figure was for transportation, a considerable saving could have been effected by stacking the hay in lots on the range where cut, which is the method ordinarily used. In 1938 the 21 tons were cut, raked and hauled to stacks about 1 mile from the cutting site for $4.71 per ton, or a saving of 71 cents per ton, due to the shorter haul.

In 1937 some of the hay was stacked near the station headquarters where it could be fed during the winter to cattle under observation. As long as the range grass remained fairly fresh in the fall, there was very little of the grass hay used by the cows. Later in the fall, when the fresh feed was all gone and the cows were given a ration of cotton-seed cake, they began to eat the tobosa grass hay readily, and while not confined to this diet exclusively, they continued to eat the feed when available throughout the winter, and remained in good condition all winter. Even a good weed crop in the early spring apparently did not affect the relish with which they continued to eat the tobosa hay any time it was offered them.

During the winter of 1938-39 several hundred calves were fed on the Jornada for the spring market. The ration consisted of oil cake with the tobosa hay as roughage or filler. When scattered over the feed lot or fed from racks, the calves cleaned up every straw of the tobosa and appeared to thrive even better than if they had been fed on alfalfa hay.

The opinion expressed by some stockmen that tobosa hay is not worth the trouble of putting it up because cattle would not eat the hay unless starved to it, is probably due to wrong methods of harvesting the grass. It must be cut while still green and succulent and possibly at a little earlier stage than for most hay plants. If allowed to ripen and become mature, the hay is unfit for feed because of the hard and woody texture of the stems.

According to W. E. Watkins, nutrition chemist and associate in Animal Husbandry at the New Mexico State College, the hay obtained from this grass when cut at the right time of the year compares very favorably with some of the best prairie hay of the middlewestern states. The protein content of tobosa grass is highest when the plant is in the early stages of growth. However, the production of hay at this stage would not be sufficient to justify the cost of harvesting. The maximum yield consistent with high quality is secured when the grass is cut while in full bloom, and it should be stacked or baled before becoming too dry in the field. As one stockman put it, the way to get the best tobosa hay is "to cut the grass just before you think it is ripe enough, and stack it just before you think it is dry enough." When properly prepared, tobosa grass hay compares favorably from a nutritive standpoint with any other hay and has the characteristic fragrant odor and color of fresh-cut hay and will be relished by both cattle and horses.

A 24-YEAR GRAZING MANAGEMENT STUDY IN A BLACK GRAMA TYPE

By Fred N. Ares, Superintendent
Jornada Experimental Range

The purpose of this stop is to discuss with you the results obtained from observations on the use and management of black grama.

Pasture 10 which we are in now originally included 4,805 acres but was enlarged to 7,172 acres in 1927. Black grama is the principal forage species and associated with it are sand dropseed and three-awn grasses. Annual and perennial weeds are negligible in quantity. Shrubs are represented by snakeweed and soapweed.

The pasture has been stocked every year, although during the grazing years 1925-26 to 1928-29 it was lightly stocked because of liquidations by the previous cooperating stockman. In 1915 there was very little basis for determining the grazing capacity of ranges in southern New Mexico. The pasture therefore had to be stocked on a trial and error basis. Subsequent measurements of forage production and degree of utilization showed that the original estimated capacity was too high. Since 1924 the pasture has been stocked at a much lighter rate than during the early years of the experiment. During most of the period the pasture was subject to semi-deferred use; that is, it was lightly stocked during the summer growing season and then the number of livestock in the pasture was increased during the fall, winter, and spring. The variation in forage crop, the annual stocking (expressed in terms of cattle year long), the annual degree of utilization, and the estimated forage produced each year in this pasture for the 24-year period are shown in table 1.

Table 1. Percent forage crop, actual stocking, percent utilization, and estimated full stocking rate in pasture 10 for the period 1915 to 1939, inclusive.

(1)	(2)	(3)	(4)	(5)
Year	Annual Forage Crop	Actual Stocking	Utilization	Estimated Full Stocking
	%	CYL	%	CYL
1915-16	125	155	95	163
1916-17	100	111	100	111
1917-18	88	238	200	119
1918-19	94	144	100	144
1919-20	94	116	100	116
1920-21	88	158	100	158
1921-22	113	51	100	51
1922-23	50	50	100	50
1923-24	44	73	100	73
1924-25	44	42	60	70
1925-26	81	1	1	100
1926-27	113	26	15	173
1927-28	113	63	35	180
1928-29	113	56	35	160
1929-30	88	97	60	162
1930-31	113	44	40	110
1931-32	94	85	70	121
1932-33	125	112	60	187
1933-34	100	182	86	212
1934-35	37	111	101	109
1935-36	100	59	64	92
1936-37	93	64	87	74
1937-38	92	96	90	109
1938-39	100	97	50	194
Average		93		126

For the first 12 years of the study the area of the pasture was 4,805 acres. While fence changes in 1927 added 2,367 acres, the stocking figures for the entire 24 years have been adjusted on the basis of the original area of 4,805 acres.

Column 1 - Grazing years from July 1 to June 30.
Column 2 - Average forage crop considered as being 100 percent.
Column 3 - CYL = cattle year long.
Column 4 - On the basis of 100 percent being proper use.
Column 5 - Based on actual stocking and percent utilization. Values in this column are largely theoretical.

In the earlier years of the experimental study, the estimated forage crop produced was based on rather general observations. During recent years an attempt has been made to secure a quantitative measure of the forage crop produced. However, sampling methods thus far developed are either too intensive for practical application to a pasture of this size or, if sufficiently extensive to be practical, the estimates are likely to give only approximations. Because of the difficulties encountered in measuring the forage crop produced, the figures given in the second column of table 1 can only be considered as approximate values representing the variability in forage production from year to year.

The actual stocking figures (column 3) are based on monthly pasture records. The percentage utilization (column 4) was measured each year at the end of the grazing season in June. Since 1924, detailed utilization surveys have been made each year. The degree of utilization was determined by ocular observation in the field and took into account density and composition for all species within the type.

Vegetational changes from year to year were measured on seven grazed plots within Pasture 10 and one plot closed to grazing. The changes in vegetational density during the period on the ungrazed plot showed a downward trend from 1915 to 1924. Since that time, the trend has been gradually upward with a sharp downward break in 1934 and a rapid upward trend from 1935 to 1938. The density of black grama showed the same general trend as the total plant density, but its fluctuation between wet and dry years was greater. The associated species, including sand dropseed and the three-awn grasses, showed a general upward

trend in density during the entire period but became relatively less important as the density of black grama increased.

The seven plots open to grazing showed a strong downward trend in density from 1915 to 1924 during a period of rather favorable rainfall. Following the change in basis of stocking initiated during the grazing year 1924-25, there was a rapid increase in density of perennial grasses. The maximum development was reached about 1932 to be followed by an appreciable loss of density in 1934, which has since been entirely regained. Comparing the grazed and ungrazed plots, we find that from 1915 to 1924 the grazed plots had a lower density, but since that time they have equaled or exceeded the ungrazed plots in density. Black grama, the most important forage species, suffered most from close grazing, and while it was susceptible to drought, made a rapid recovery under moderate stocking. Actually the ungrazed plots showed a greater loss in density from drought and a smaller maximum density under favorable rainfall conditions.

On the evidence at hand and making due allowance for fluctuations in rainfall, we are reasonably sure that since 1924 Pasture 10 has not been deteriorating. The total density of perennial grasses is greater now than in 1915, and black grama has a greater density and makes up a larger percentage of the total vegetation than at the beginning of the study.

Column 5 in table 1 shows the theoretical number of cattle years' forage produced from year to year. Assuming that our estimates of utilization have been reasonably correct, the figures given in the

last column would represent the number of cattle (grazing year long) which would fully utilize the forage produced. However, this and other studies have shown that black grama ranges will deteriorate if the total available forage is fully used each year and will not maintain themselves even if stocked on the basis of full use of average forage production. Because of the damage to the perennial grasses from excess stocking in droughty years, it is necessary to stock at a lower rate. Under conditions such as found in Pasture 10, it is not safe to stock to more than 75 percent of the average forage production. Then if we take 126 (the average shown at bottom of column 5) as the average number of cow years' forage produced, the grazing capacity of the original pasture (4,805 acres) would be 94 head (75 percent of 126). Or, expressed in another way, range of this type under deferred grazing use has a grazing capacity of 12 head to the section on a yearlong basis.

EXPERIMENTAL SET-UP TO STUDY METHODS FOR THE RESTORATION OF CREOSOTEBUSH RANGE

By Kenneth A. Valentine, Junior Range Examiner,
Jornada Experimental Range.

This stop is made to acquaint you with some of the work being done on the Jornada with regard to restoration of forage plants in the creosotebush vegetation type. This installation, one of three already set up on the Jornada, consists of a block of 16 plots, each plot being 70 feet square. Four treatments have been used on the area: (1) removal of brush, (2) construction of shallow basins to retain some of the rain falling on the area, (3) exclusion of rodents, and (4) reseeding to perennial forage grasses.

These treatments were selected because it appears that they will provide for the inclusion of the factors most favorable toward the restoration of the type and the exclusion of the most adverse factors. Artificial retention of rainfall, much of which is normally lost as run-off from the denuded area, will do much toward rendering the site favorable for establishment of desirable plants. Likewise, supplying seed of perennial grasses will greatly hasten recovery of this area since the plants which would naturally supply seed have all but disappeared from the area. Observations indicate that elimination of the almost worthless shrubs and prevention of the excessive damage to forage plants by rabbits, which always prevails on such severely deteriorated

areas, especially the latter treatment, are most important steps in the restoration of depleted ranges in this section.

The treatments are applied singly and in all possible combinations of two at a time, three at a time, and four at a time. One check plot is also included in this block on which no treatment is applied. One of the plots in the block will thus have all treatments applied to it, one will have no treatment, four will have single treatments, and the remaining ten plots will have the various combinations of double and triple treatments applied.

This block of plots was completed late in the past growing season, hence no effects of the treatment as regards restoration of the area are discernible. On the other two blocks, however, which have had the advantage of a full growing season since completion, indications of some improvement are evident. Grass seedlings from the artificial reseeding are appearing, and the few grass plants remaining on the areas at the time of the establishment of the blocks are growing thriftily.

In the Dona Ana Revegetation Enclosure, a few hundred feet west, which we shall see presently, work similar to this just described has bornefruit in the establishment of a light stand of the desirable perennial grasses formerly present on the area. This stand, while much lighter than the original, is a definite improvement over the conditions represented by the almost barren soil surface of the surrounding area.

Time is of course an element in any such restoration experiments, especially so under the severe climatic conditions prevalent in the semiarid Southwest. These artificial treatments are undertaken in an attempt to shorten the long period which would undoubtedly be required without such aids. It is quite possible, however, that some artificial aids, notably control of rodents, may be altogether necessary in order to bring about an improvement from the severely deteriorated condition observable here toward the productive cover of perennial grasses that we know existed on this site in the past.

RANGE DETERIORATION AND THE POSSIBILITY OF IMPROVEMENT

By W. G. McGinnies, Range Ecologist,
Southwestern Forest & Range Experiment Station.

During most of the day attention has been directed toward maintenance and improvement of the range, but in this particular case we want to discuss range depletion.

The area where we are now once supported much more forage than it does now. We have pictures to show that there was a good stand of grass here 20 years ago. We have many records in our files which show that there has been a steady decline in forage grasses and a corresponding increase in shrubs since 1915.

We are chiefly interested in five questions as they relate to this area:

1. What was the original vegetation?
2. What changes have taken place?
3. What caused these changes?
4. How can such deterioration be prevented?
5. How can ranges in similar condition as this be improved?

From available photographs, quadrat records, and maps, we are able to piece together a pretty good picture of the original vegetation on this area. If you had been here 25 years ago, you would have seen an open stand of shrubs mostly on the ridges with patches of fairly dense black grama and sand dropseed occupying the spaces between the shrubs. You would have considered it good range, and if it belonged to you, you probably would have gone right into the bank to borrow money to buy more cows to use up what might appear to be surplus feed.

Thus the points I want to make are, that this was formerly good range, that there are other areas now occupied by creosotebush and blackbrush that once supported a grass cover, but that it is not true that all of the areas now covered with shrubs were once grassland, nor is it anymore true that all areas now covered with shrubs were always that way.

From the range viewpoint we are not very much worried about the areas that have always been in shrubs because probably there is very little that we can do to change them. We are, however, interested in the ranges that have changed from grass to shrubs, because we may be able to reverse the process and get them back to grass again.

Before we can reverse the process, we must know why the changes have taken place. Was it because of declining rainfall? Or because of heavy grazing?

When we know the reasons why the changes have taken place we may be able to work out a plan for their restoration. It is true that we can't change the rainfall, but we can increase the amount of soil moisture by soil conservation measures. If the changes have been due to grazing, we can correct the situation through management practices.

The evidence in this particular case all points toward grazing as the primary cause for the changes which have taken place. During the past there has been a concentration of grazing in this area. As a result the perennial grasses were killed out, erosion became more rapid, the soils lost much of their humus and mineral nutrients, and as a result the perennial grasses were replaced by annuals and shrubs. The changes outside of the enclosure were such as to affect vegetative growth inside through erosion and deposition.

Range depletion such as this can be and is being prevented by livestock management based on experimental studies. Those studies have shown that if the perennial grasses are not too closely grazed the grasses will remain vigorous, the rainfall will be efficiently used, and the valuable topsoil will be saved.

The management practices in themselves are very simple and easily applied. They are based on leaving enough vegetative material to promote regrowth and to provide humus replacement in the soil. As our patient - the range - is recovering from an illness, it must have some rest and must be lightly used until it has recuperated. This means that the use should be such that at the end of the grazing year it would appear that at least half of the vegetative production of the important grasses has been left on the ground. Deferring use until after the growing season will help some, but the important thing is to leave lots of stubble for the new growth to start from. Range types, such as this is, and such as it used to be, are very "touchy" and must be managed with care, but if they are so handled, will prove to be the basis for profitable range production.

SOIL CONSERVATION IN THE SOUTHWEST

By R. A. Young, Area Conservationist - Mesilla Area,
Soil Conservation Service.

It is becoming increasingly apparent, as evidence gathers, that the range-livestock industry and irrigation farming, two of the three principal industries in the Southwest, are threatened by soil erosion. The thin film of surface soil that nourishes the vegetation that stock convert into beef, mutton and wool and absorbs the water that keeps streams alive and steadily flowing, is washing from range lands at a rate for which there are few known precedents anywhere in the world.

The consequences of accelerated erosion in the Southwest are far reaching. Damage is not restricted to the loss of forage and soil from the range lands. Soil erosion and rapid surface run-off and floods usually are associated; often they are companion phenomena. In recent years floods of increased violence frequently have inundated villages, towns, and cities. Farm lands and irrigation works along the principal rivers, where the bulk of the population lives and labors, have been damaged or ruined by overwash of sand and gravel, by waterlogging, and by cutting of new channels.

The key to control of erosion on range land in the Southwest is range management. The principal factors usually considered under range management are: (1) Proper stocking of the range as to numbers; (2) proper stocking as to kind of livestock; (3) correct seasonal use; and (4) proper distribution of stock over the range.

In proper range utilization, proper stocking as to numbers is most important; without it, efforts toward forage protection and erosion control are usually futile. Until proper stocking is achieved, it is

hardly worth while, in the opinion of the technical men of the Soil Conservation Service, to apply additional erosion-control measures. To do so, they feel, is to ignore the teachings of 50 years. The history of the range shows that fundamentally the cause of the present depleted state of plant cover, and excessive erosion, is 50 years of stocking beyond the grazing capacity of the range. Many examples of depleted grasslands that have recovered under conservative stocking or exclusion of stock support this opinion. The College Ranch and the Jornada Experimental Range are excellent examples of recovery under conservative grazing. The Las Cruces Watershed is an outstanding example of recovery under total exclusion.

If erosion were controlled in its early stages, when vegetation first starts to give way, when the first small rills are forming in the upper reaches of the watershed, the use of structures might be unnecessary. But over tens of millions of western acres, erosion has gone far beyond the early stages, also considerable flood damage occurs from run-off on well vegetated slopes, due to periodic torrential rains.

In addition to proper range management the following structural treatments have proved effective in the Mesilla Area in many instances:

A. Water Spreaders, as the term implies, are used to spread water that is concentrating in gullies or arroyos. A spreader may be a large or small structure and may be made of earth, rock, brush, or a combination of these materials.

B. Contour Furrowing is considered by many to be one of the most effective soil and moisture conserving practices. As a means of controlling run-off contour furrowing needs no defense. They have been used very effectively on the Las Cruces and Hatch watersheds. These furrows have been designed to hold a one-inch rain.

C. Percolators constructed of native rock, brush, or a combination of these materials have been widely used to retard run-off and silt movement from the hillsides. The function of the percolator is not to retain water but to retard its flow and thus allow more time for moisture to penetrate more thoroughly and deeply into the soil.

D. Gully Detentions or Small Check Dams can often be justified to protect irrigated land or irrigation works immediately below a gullied area or to stabilize the bottoms and banks of gullies which are causing damage to valuable lands and properties below.

E. Stream Bottom Fences - Even when a range is conservatively grazed the concentration of livestock along drainage channels often prevents natural recovery of the vegetation which would normally stabilize the banks of streams or washes. It is often advisable to fence these channels for a period of two or more years in order to promote natural recovery.

F. Detention Dams - Oftentimes run-off water in the large arroyos cannot be successfully spread and, therefore, must be controlled by means of a detention dam using an outlet which allows the peak flows to slowly dissipate through the regular channel. Ordinarily detention dams are not justifiable except to provide protection for towns and municipalities or large areas of valuable farm lands.

An exhibit prepared by Region Eight of the Soil Conservation Service, depicting Soil and Moisture Conservation in the Southwest, is on display at Jornada Range Headquarters.